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Opt 2 soil borings convert to shallow VWs

email Deb Soper

March 2, 1998

Major Ed Marchand
AFCEE/ERT
3207 North Road, Bldg. 532
Brooks AFB, Texas 78235-5363

Subject: Results of Bioventing System Monitoring at the Davis Global Communications Site, McClellan Air Force Base, California (Contract F41624-92-8036, Order 17)

Dear Major Marchand:

This letter presents the results of the bioventing system monitoring performed by Parsons Engineering Science, Inc. (Parsons ES) in July 1997 at the Davis Global Communications Site (Davis Site) administered by McClellan Air Force Base (AFB) and located in Davis, California. Soil gas samples were collected and *in situ* respiration testing was performed by Parsons ES between 21 and 24 July 1997 to assess the extent of remediation completed during approximately 4 years of air injection bioventing at the site. The purpose of this letter is to summarize remediation activities to date, present the results of the July 1997 system monitoring event, compare the results with previous monitoring events, and recommend future remediation activities for the site.

SITE DESCRIPTION

The Davis Site is located approximately 20 miles southwest of McClellan AFB in Davis, California and occupies approximately 316 acres in a predominantly agricultural area (Figure 1, attached). Environmental investigations at the site began in 1981 and the site is currently part of the USAF Installation Restoration Program (IRP). Chlorinated volatile organic compounds (VOCs) and petroleum products have been detected in soil, soil gas, and groundwater at the Davis Site.

Bioventing at the Davis Site is currently being conducted at the former location of three 25,000-gallon underground fuel storage tanks (UFSTs). The UFSTs were located in the southeast portion of the Main Compound Area and were used to store diesel fuel for a generator housed in Building 4710 (Figure 2, attached). In February 1985, fifty-two cubic yards of contaminated soil were removed from above the UFSTs and found to be saturated with petroleum product. The exposed UFSTs showed deformation and the pipelines associated with the UFSTs were found to be leaking. In May 1985, the remaining fuel in the UFSTs was removed and an above ground diesel fuel storage tank was installed on the north side of Building 4710 to replace the UFSTs. In May 1987, concentrations of trichloroethene (TCE) and tetrachloroethene (PCE) exceeding state action levels were detected in groundwater sampled from an on-site production well (the source of the chlorinated VOCs in groundwater was later determined to be unrelated to the UFSTs). In May 1988, all three UFSTs were removed from the site and the excavation was backfilled

AQM01-04-0648

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with clean soil. A more detailed description of the site history and site investigations prior to 1993 are provided in the Bioventing Pilot Test Work Plan prepared for the site (Engineering-Science, Inc. [ES], now Parsons ES, 1994).

SITE GEOLOGY

The subsurface lithology of the site near the former UFSTs consists of fill material, below which are laterally continuous intervals of clay, clayey/silty sand, sand, and gravels (Figure 3, attached). The uppermost unit to a depth of between 6 and 13 feet bgs is a fill material consisting of brown, sandy/clayey silt with minor amounts of gravel. The concrete pad used to anchor the former UFSTs was left in place after tank removal and was encountered at a depth of approximately 13 feet bgs.

The native soil below the fill material to approximately 25 feet bgs is a silty, lean clay. The clays are slightly stiff to stiff in parts and exhibited blue-green discoloration and noticeable fuel odor. From approximately 25 to 30 feet bgs are predominantly clayey sands. Fine to medium-grained sand was found in all borings from approximately 30 to 35 feet bgs. This sand grades downward to an approximately one foot thick interval of basal gravel. From this gravel interval to the bottom of the boreholes, the soils are predominantly clayey silts and silty clays.

SITE REMEDIATION HISTORY

In July 1993, ES installed a pilot-scale bioventing system at the site as part of the Air Force Center for Environmental Excellence (AFCEE) Bioventing Pilot Test Initiative (Contract No. F33615-90-D-4014, Order 14). The installed pilot-scale bioventing system consisted of one vent well (VW), designated VW-1, three vapor monitoring points (VMPs), designated VMP-1, VMP-2, and VMP-3, and one background VMP, designated VMP-4. Figure 2 depicts the site layout, the location of the blower, the bioventing vent well (VW-1), vapor monitoring points (VMPs), and the approximate boundary of the former UFST excavation. During the installation of the pilot-scale system, soil and soil gas sampling and respiration and air permeability testing were performed. A 1.0-horsepower, regenerative blower unit configured for air injection at VW-1 was installed for long-term pilot test operation and contaminated soils remediation. A more detailed description of the pilot-scale bioventing system design, installation, and results are provided in the Bioventing Pilot Test Interim Results Report prepared for this site (ES, 1994).

During installation of the pilot test system in 1993, field organic vapor analysis (OVA) was conducted on soil headspace from soil samples collected in all boreholes. In VMP-2 and VMP-3, the highest OVA readings were generally recorded from approximately 45 feet bgs to groundwater, which was encountered at approximately 55 feet bgs at that time. In VW-1 and VMP-1, OVA readings were highest below the base of fill (between 5 and 10 feet bgs) and readings above 100 part per million by volume (ppmv) were encountered all the way to groundwater. Blue and/or blue-green discoloration and fuel odors were also noted in all boreholes that penetrated native soils beneath the fill. All boreholes encountered evidence of hydrocarbon contamination at the capillary fringe and in the

smear zone created by seasonal groundwater fluctuations. The seasonal groundwater fluctuations are typically 25 feet, but have been measured as high as 40 feet. These results suggest that seasonal groundwater fluctuations are responsible for some of the petroleum-hydrocarbon contamination in soil and that more significant sources of contamination are closer to VW-1, which is also closer to the former location of the leaking fuel pipelines. At the background VMP (VMP-4), located approximately 325 feet north-northeast of VW-1, no contamination was observed in the physical features of the soil or determined based on the OVA readings.

Laboratory analyses of soil samples collected in 1993 during installation of the VW and VMPs also indicated higher concentrations of petroleum hydrocarbons at VW-1 than at the VMPs. The maximum detected concentration was 15,500 milligrams per kilogram (mg/kg) of total recoverable petroleum hydrocarbons (TRPH) in a sample collected from 32.5 feet below ground surface (bgs) at VW-1. Benzene, toluene, ethylbenzene, and total xylenes (BTEX) and chlorinated volatile organic compounds (VOCs) were not detected in any soil sample. The source of the chlorinated VOCs in groundwater was determined to be unrelated to the UFSTs based on this data and prior and subsequent investigations.

Laboratory analysis of soil-gas samples collected from the VW and VMPs in 1993 after their installation documented hydrocarbon contamination and low concentrations of BTEX and chlorinated VOCs. BTEX compounds and chlorinated VOCs did not exceed 1.2 parts per million by volume [ppmv] for any analyte, consistent with the lower mass fraction of BTEX in diesel fuel compared to other fuels and the determination that the source of the chlorinated VOCs was not the former UFSTs. The maximum detected total petroleum hydrocarbon (TPH) and BTEX concentrations were: 380 part per million by volume (ppmv) TPH as jet fuel (TPH-jf), 0.0067 ppmv benzene, 0.013 ppmv toluene, 0.62 ppmv ethylbenzene, and 1.1 ppmv total xylenes. The maximum detected concentrations of chlorinated VOCs were: 0.017 ppmv 1,2-dichloroethane, 0.0091 ppmv cis-1,2-dichlorethene, 0.86 ppmv Freon 113, 0.094 ppmv Freon 12, 0.015 ppmv trichloroethene (TCE), and 0.0051 ppmv vinyl chloride (ES, 1994).

In June 1996, soil vapor extraction (SVE) and groundwater extraction operations were initiated at the Davis Site as part of remediation efforts for the TCE contamination in groundwater. The SVE system is being operated by OHM Remediation Services under AFCEE Contract F41624-94-D-8106, Order 15. One of the wells used for SVE, CH-5, is located near the bioventing pilot test area (Figure 2). Therefore, since June 1996 the contaminated soils have been undergoing a combination of air injection at VW-1 and air extraction at CH-5. CH-11, a soil vapor monitoring point installed in August of 1996, is also being used to monitor the performance of the SVE system.

The bioventing pilot test provided for one year of pilot-scale system operation and *in situ* respiration testing. Oxygen influence measurements were conducted three weeks after system start-up and periodically during extended operation of the system over the last 4 years to measure the effectiveness of the blower in providing oxygen to the contaminated soils. Results from the extended system operations, including oxygen measurements and analytical results for soil-gas samples, are provided in Table 1.

Oxygen measurements were taken on samples collected while the system was in operation and on samples collected after air injection and extraction at VW-1 and CH-5 were terminated to allow soil to reach equilibrium conditions (approximately 30 days). The results from these two types of measurements indicate the effect of air injection on aerating site soils and indicate whether significant oxygen demand still exists. Measurements were taken prior to system start-up and after 3 weeks and 1, 2, 3, and 4 years of operation. The results indicate that air injection is successful in aerating the more permeable soils below approximately 25 feet bgs at the site. All VMP screens below 25 feet bgs showed significant increases in oxygen concentration between times when the blower was not operating and when the blower was in operation. Most of the samples collected below 25 feet bgs had measured oxygen concentrations equal to or greater than 18% while air injection was occurring.

Based on measurements taken at the 15-foot screens in VMP-1 and VMP-2, air injection appeared to be somewhat less effective in the lean, silty clay soils between the fill material and 25 feet bgs. The 15-foot screen in VMP-1 generally shows little to no oxygen response, while the 15-foot screen in VMP-2 does show oxygen response, although less pronounced than in the deeper soils. The lower effectiveness of air injection in the upper clays is probably a combination of tighter soils in the formation, higher moisture contents, and because most of the air flow in the VW will preferentially flow to the deeper, more permeable formation below 25 feet bgs rather than the upper less permeable formation above 25 feet bgs. Purging and sample collection of soil gas from the shallow VMP depths is often problematic due to very tight and moist soil conditions.

As part of the initial bioventing pilot test, respiration tests were conducted initially (prior to system startup in August 1993) and after six months and one year of operation (in March 1994 and September 1994, respectively). Respiration test results are provided in Table 2. Air injection and extraction at VW-1 were terminated for approximately 30 days prior to the one-year respiration test to allow soils and soil gas to reach equilibrium (representing "static" conditions) to compare with initial soil conditions. The respiration test results at the end of 6 months and the first year of operation and the equilibrium oxygen concentrations at the end of the first year indicated that contaminated soils were still exerting a significant oxygen demand. Biodegradation rates at the end of the first year ranged between 440 and 4,200 mg/kg of TPH per kg of soil per year. Soil and soil-gas sampling results at the end of the first year of operation also indicated that fuel residuals remained in the soil, although concentrations were generally lower than those measured initially (AFCEE, 1995). Continued operation of the pilot test system was recommended at that time.

Results from the one-year bioventing pilot test demonstrated that *in situ* bioventing could be an effective method to remediate vadose zone soils at the Davis Site by aerobically enhancing biological fuel degradation. Based on the favorable bioventing pilot testing results at the Davis Site, funding was allocated for bioventing system maintenance with year-end respiration testing and soil gas sampling (Option 1). This letter reports the Option 1 year-end testing event for the Davis Site at the end of the fourth year of operation.

OPTION 1 TESTING RESULTS

Soil Gas Chemistry Results

Soil-gas samples were collected at the Davis Site for field screening in June 1997, during air injection/extraction operations, and in July 1997, approximately 45 days after air injection/extraction operations were ceased. The purpose of the two separate sampling events was to evaluate the effect of air injection/extraction on aerating site soils and to allow soils and soil gas to reach equilibrium so that results would be comparable with initial soil conditions. Soil-gas samples for laboratory analysis were collected immediately after the July 1997 field screening samples were collected.

Soil gas sampling results from the Option 1 testing events are presented in Table 1. During the July 1997 sampling event, equilibrium soil gas oxygen concentrations were less than or equal to 5% at all sampled locations in VMP-1 and the 15-foot sampling location in VMP-2. Equilibrium oxygen concentrations were greater than 9% at all other sampled locations. Groundwater was measured at a depth of 43 feet bgs in July 1997; therefore, samples could not be obtained from the 48-foot, 49-foot, and 45-foot depths in VMP-1, VMP-2, and VMP-3, respectively. These equilibrium oxygen concentrations are consistent with previous oxygen measurements discussed above. Previous results indicated that shallow soils (those above 25 feet bgs) at VW-1 and VMP-1 have higher contaminant concentrations and are more difficult to aerate than deeper soils. Therefore, residual soil contamination in these shallower soils are probably continuing to act as a source of contamination for infiltrating recharge and during times when groundwater is in contact with them.

Nevertheless, air injection at VW-1 is effective in aerating and remediating the petroleum-hydrocarbon contamination in deeper soils and, to a lesser extent, the shallow soils at VMP-2. The radius of influence in the deeper soils was estimated at approximately 110 feet from VW-1 based on pressure response in August of 1995. Continued air injection into the deeper soils could be expected to provide some degree of protection for groundwater when the groundwater is not in direct contact with the shallow, contaminated soils.

Groundwater monitoring results for the First Quarter of 1997 (Radian, 1997) for the site indicate that the groundwater beneath the former UFST excavation is within the capture zone of the operating groundwater extraction system. Chlorinated VOCs unrelated to the former UFSTs continue to drive the groundwater extraction and remediation effort at the Davis Site. During the First Quarter of 1997, the maximum TCE, tetrachloroethene (PCE), and 1,1-dichloroethene (1,1-DCE) concentrations in samples collected from downgradient monitoring wells were 10.8 micrograms per liter (ug/L), 74.7 ug/L, and 6.14 ug/L, respectively. BTEX compounds in the nearest downgradient monitoring wells (DMW-2 and DMW-3) are below maximum contaminant levels (MCLs) for drinking water.

During the July 1997 sampling event, soil-gas samples were also collected for laboratory analysis at VW-1, VMP1-15, VMP1-37.5, VMP2-15, and VMP3-35. Samples were submitted under chain-of-custody to Air Toxics, Ltd. in Folsom, California, and

analyzed for TPH-jf and BTEX using U.S. Environmental Protection Agency (USEPA) Method TO-3. Results for TPH-jf and BTEX concentrations for all samples are provided in Table 1. At the request of McClellan AFB, samples were also collected from the two screened intervals in CH-11, a soil vapor monitoring point installed in August of 1996 (Figure 2). The samples from CH-11 were analyzed by both USEPA Method TO-3 for TPH-jf and BTEX and by USEPA Method TO-14 for volatile organic compounds (VOCs), including chlorinated compounds. Copies of the analytical reports for the samples collected from CH-11 and analyzed by USEPA Method TO-14 are provided in Attachment 1.

The analytical results were consistent with the field screening results, with both TPH-jf and BTEX concentrations highest in shallow soils at VMP-1. Good correlation existed between soil gas concentrations and oxygen concentrations, indicating that oxygen concentrations are an effective indicator of remediation progress.

Because of the groundwater elevation at the time of the Option 1 sampling event (43 feet bgs), soil-gas samples could not be collected from all previously sampled locations. For the one VMP location where initial (baseline), one-year, and 4-year soil-gas sampling was performed — VMP-1 at 37.5 feet bgs — results indicate reductions in both TPH-jf and total BTEX concentrations and increases in equilibrium oxygen concentrations with each successive sampling event. During the Option 1 sampling event, soil-gas samples were collected for laboratory analysis for the first time from VMP1-15 and VMP2-15. Results indicated TPH-jf and BTEX concentrations were within the order of magnitude of initial (baseline) measurements at VMP1-37.5 and VMP3-45 and the one-year sampling at VMP2-49, indicating that the shallow soils will probably require longer remediation times and/or more aggressive efforts because they are significantly more difficult to aerate.

Remediation progress at other locations can be inferred from increases in equilibrium oxygen concentration. Equilibrium oxygen concentrations greater than 5% and approaching background conditions (approximately 17% at the Davis Site) were measured at VMP2-32, VMP2-43, VMP3-26, and VMP3-35, indicating remediation progress at those locations. Equilibrium oxygen concentrations were less than or equal to 5% at all sampled depths at VMP-1 and at VMP2-15, indicating that petroleum-hydrocarbon contamination continues to exert significant oxygen demand at those locations.

Respiration Testing Results

After the soil gas sampling was completed at the Davis Site, an *in situ* respiration test was performed according to procedures outlined in the AFCEE bioventing protocol document (Hinchee *et al.*, 1992). Air was injected at approximately 1 cubic foot per minute (cfm) for 20 hours to locally oxygenate the soils at the following VMPs and depths: VMP-1 at 25 ft bgs and 37.5 ft bgs; VMP-2 at 15 ft bgs; and, VMP-3 at 35 ft bgs. Following the air injection period, changes in soil gas oxygen, carbon dioxide, and TVH concentrations were monitored over a 52-hour period. Observed rates of oxygen utilization were then used to estimate aerobic fuel biodegradation rates as described in the AFCEE bioventing protocol document. Table 2 (attached) presents the results of respiration testing performed in July 1997 and during all previous respiration tests.

After one year of bioventing, the oxygen utilization rates had increased compared to initial rates, indicating a significant amount of fuel hydrocarbons remained in the soil at that time. Oxygen utilization rates are still significant at VMP-1 and VMP-3 after four years of air injection; however, the rates are lower than those measured during prior respiration tests. The maximum oxygen utilization rate (2.1% per hour) was measured at VMP2-15; the rates at VMP-1 and VMP-3 were significantly less (0.44 % per hour and 0.11% per hour, respectively). Estimated fuel biodegradation rates ranged from 210 to 3,630 mg of fuel per kg of soil per year. Although oxygen utilization rates have decreased, fuel biodegradation continues to be enhanced by air injection bioventing at the site.

FUTURE REMEDIATION ACTIVITIES PLANNED AT THE DAVIS SITE

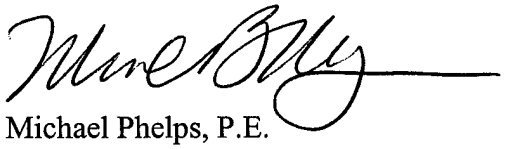
Bioventing, soil vapor extraction, and groundwater extraction are planned to continue at the Davis Site for the next year. The results of the Option 1 testing event indicate that petroleum hydrocarbons remain in site soils, especially the shallow, clay-rich soils which are difficult to aerate. Residual soil contamination in these shallower soils are probably continuing to act as a source of contamination for infiltrating recharge and during times when groundwater is in contact with them.

Nevertheless, air injection at VW-1 is effective in aerating and remediating the petroleum-hydrocarbon contamination in the smear zone, the deeper soils, and to a lesser extent the shallow soils at VMP-2. Continued air injection into the deeper soils could be expected to provide some degree of protection for groundwater when the groundwater is not in direct contact with the shallow, contaminated soils. The data collected indicates that although petroleum contamination still exists at the Davis Site, the risk-driving BTEX compounds are present at relatively low concentrations in both soil and soil gas. Recent groundwater monitoring results downgradient of the site indicate that the contaminated soils are not impacting groundwater above the MCLs for BTEX compounds.

This site has been funded with an Option 2 (closure soil sampling) under the AFCEE Extended Bioventing Project. Although regulatory closure of this site may not be attainable with the Option 2 scope, AFCEE may elect to exercise the Option 2 scope to determine actual reductions in soil BTEX and TPH concentrations over the 4-year bioventing period.

If you have any questions or require additional information, please contact me at (510) 891-9085.

Sincerely,
PARSONS ENGINEERING SCIENCE, INC.



Michael Phelps, P.E.
Site Manager/Sr. Environmental Engineer

cc: Ms. Debra Soper (McClellan AFB EM)
Mr. John Ratz (Parsons ES - Denver)

REFERENCES

AFCEE 1995, Letter from AFCEE to Mr. Mario Ierardi dated 13 April 1995, Subject: Completion of One Year Bioventing Tests: Tank Farm #2; Tank Farm #4; SA-6; PRL T-46; Davis Global Communications Site.

Engineering-Science, Inc. (ES, now Parsons Engineering Science, Inc.[Parsons ES]) 1994, *Part I: Bioventing Pilot Test Work Plan for Tank Farm #2, Tank Farm #4, SA 6, PRL T-46, Building 720 McClellan AFB, California and Davis Global Communications Site, Davis, California and Part II: Draft Bioventing Pilot Test Interim Results for Tank Farm #2, Tank Farm #4, SA 6, PRL T-46, Building 720 McClellan AFB, California and Davis Global Communications Site, Davis, California.* Prepared for McClellan AFB and AFCEE. February.

Hinchee, R.E., Ong, S.K., Miller, R.N., Downey, D.C., and Frendt, R., 1992. *Test Plan and Technical Protocol for A Field Treatability Test for Bioventing*, U.S. Air Force Center for Environmental Excellence (AFCEE). May.

Radian International LLC, 1997. Installation Restoration Program (IRP) Groundwater Sampling and Analysis Program (GSAP), Data Summary - Davis Global Communications Site, January - March 1997 (Final). Prepared for McClellan AFB/EM. May.

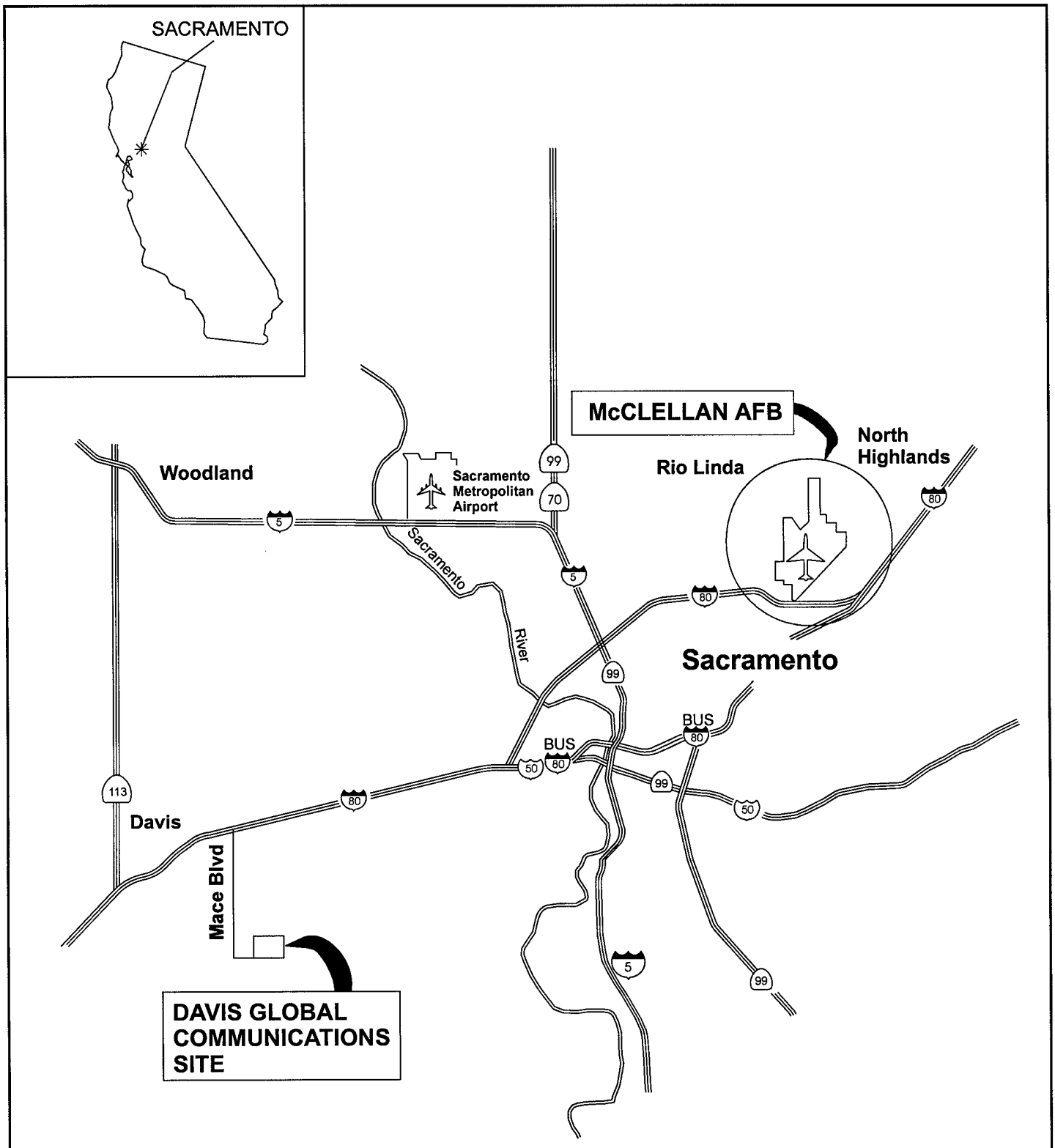


FIGURE 1

SITE LOCATION

Davis Global Communications Site
McClellan AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Oakland, California

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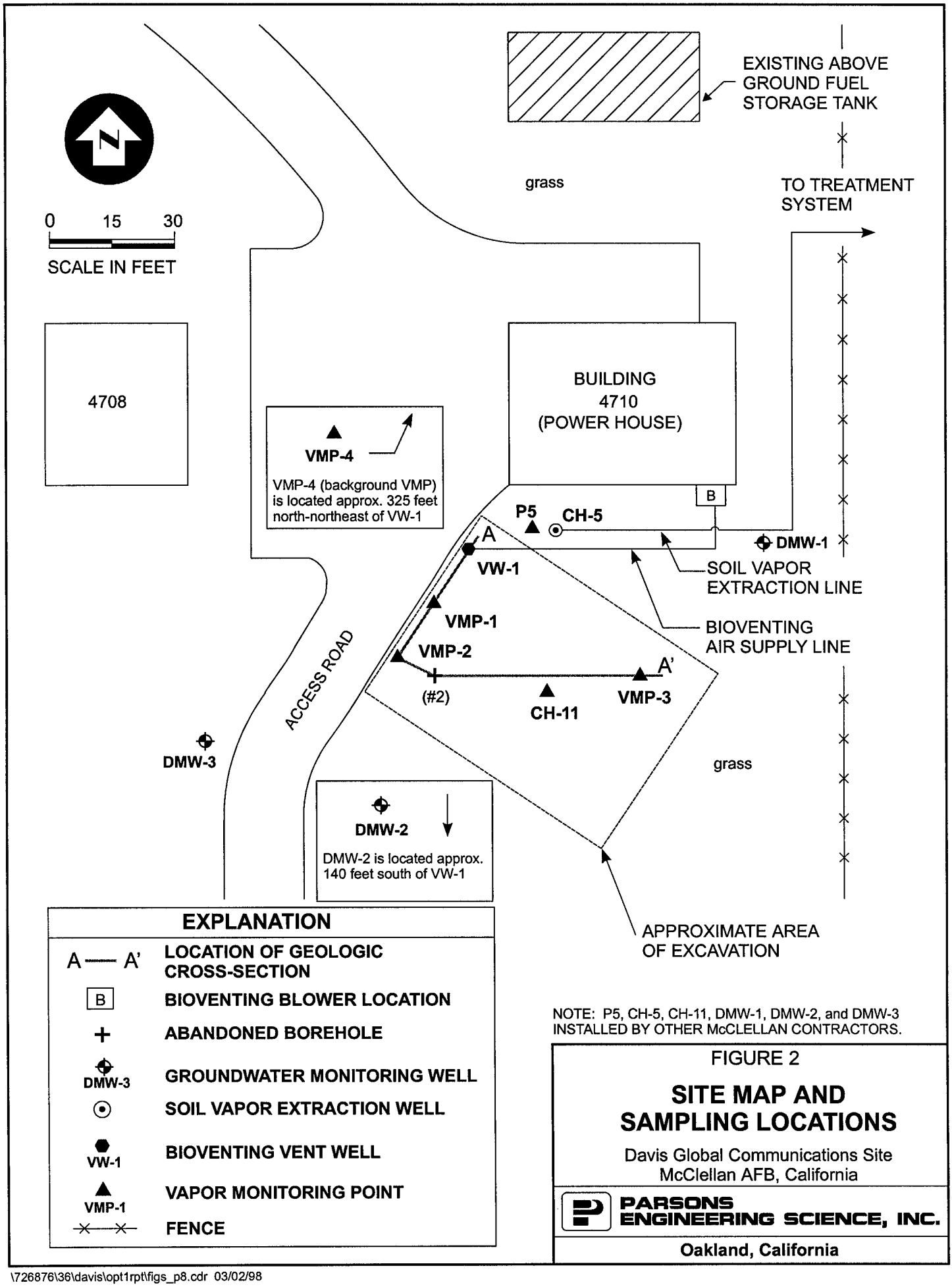

NOTE: P5, CH-5, CH-11, DMW-1, DMW-2, and DMW-3 INSTALLED BY OTHER McCLELLAN CONTRACTORS.

FIGURE 2

SITE MAP AND SAMPLING LOCATIONS

Davis Global Communications Site
McClellan AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Oakland, California

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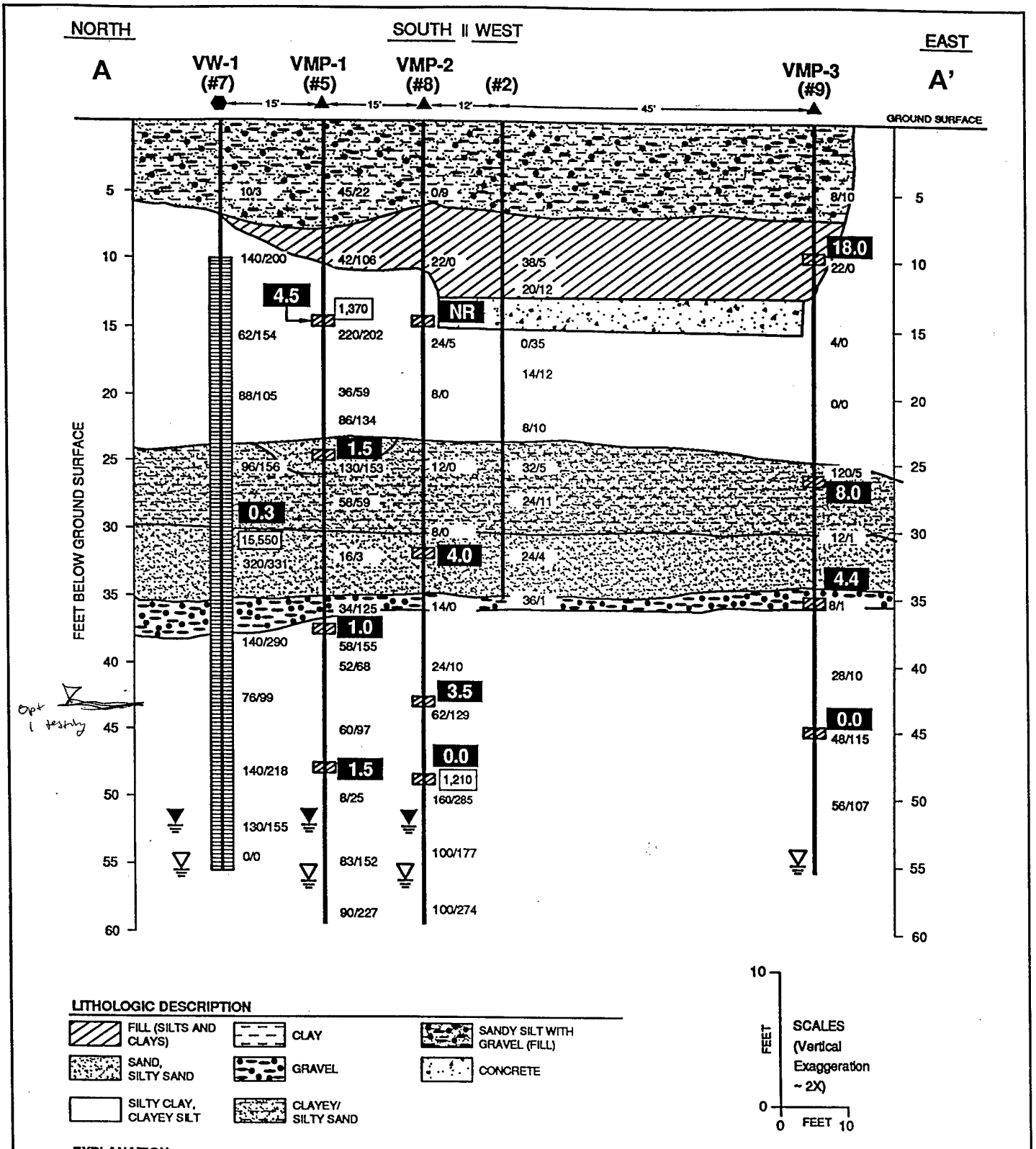

FIGURE 3

GEOLOGIC CROSS-SECTION

Davis Global Communications Site
McClellan AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Oakland, California

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TABLE 1
SOIL GAS FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
DAVIS GLOBAL COMMUNICATIONS SITE
DAVIS, CALIFORNIA

				Field Screening Data			Laboratory Analytical Data				
Sample Location	Sample Depth (ft bgs)	Sampling Event	Blower Status	O_2 (%)	CO_2 (%)	TVH (ppmv)	TPH-jf (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl-benzene (ppmv)	Total Xylenes (ppmv)
VW-1	10-55	Initial	Off	0.3	4.0	NS	84	0.0067	<0.002	0.013	0.031
		1-Year	Off	0.0	5.0	40	22	<0.002	0.002	0.003	0.065
		4-Year	Off	18.5	0.5	47	12	0.031	0.006	0.022	0.088
VMP-1	15	Initial	Off	4.5	1.2	110	---	---	---	---	---
		3-Week	On	11.5	NS	NS	---	---	---	---	---
		6-Month	On	4.0	>5	50	---	---	---	---	---
		1-Year	Off	6.2	9.8	100	---	---	---	---	---
		2-Year	On	<3.5	12.0	NS	---	---	---	---	---
		3-Year	On	3.0	9.0	NS	---	---	---	---	---
		4-Year	On	4.0	11.3	NS	---	---	---	---	---
		4-Year	Off	4.0	NS	NS	550	0.19	0.40	0.49	1.6
VMP-1	25	Initial	Off	1.5	3.7	230	---	---	---	---	---
		3-Week	On	13.5	NS	NS	---	---	---	---	---
		6-Month	On	20.2	0.30	8	---	---	---	---	---
		1-Year	Off	1.0	5.4	40	---	---	---	---	---
		2-Year	On	20.0	1.0	45	---	---	---	---	---
		3-Year	On	19.8	1.2	25	---	---	---	---	---
		4-Year	On	20.0	1.1	32	---	---	---	---	---
		4-Year	Off	0.5	1.6	140	---	---	---	---	---
VMP-1	37.5	Initial	Off	1.0	6.3	140	380	<0.011	0.013	0.55	1.1
		3-Week	On	18.0	NS	NS	---	---	---	---	---
		6-Month	On	F	F	F	---	---	---	---	---
		1-Year	Off	1.8	3.5	64	45	<0.002	0.007	0.007	0.14
		2-Year	On	F	F	F	---	---	---	---	---
		3-Year	On	20.2	0.8	22	---	---	---	---	---
		4-Year	On	20.5	0.8	20	---	---	---	---	---
		4-Year	Off	4.0	4.5	46	61 (34)	<0.002 (<0.002)	<0.002 (0.006)	0.024 (0.015)	0.021 (0.088)
VMP-1	48	Initial	Off	1.5	6.5	340	---	---	---	---	---
		3-Week	On	9.0	NS	NS	---	---	---	---	---
		6-Month	On	F	F	F	---	---	---	---	---
		1-Year	Off	1.2	6.2	180	---	---	---	---	---
		2-Year	On	F	F	F	---	---	---	---	---
		3-Year	On	F	F	F	---	---	---	---	---
		4-Year	On	F	F	F	---	---	---	---	---
		4-Year	Off	F	F	F	---	---	---	---	---

TABLE 1 (continued)
SOIL GAS FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
DAVIS GLOBAL COMMUNICATIONS SITE
DAVIS, CALIFORNIA

				Field Screening Data			Laboratory Analytical Data				
Sample Location	Sample Depth (ft bgs)	Sampling Event	Blower Status	O_2 (%)	CO_2 (%)	TVH (ppmv)	TPH-jf (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl-benzene (ppmv)	Total Xylenes (ppmv)
VMP-2	15	Initial	Off	NS	NS	NS	---	---	---	---	---
		3-Week	On	NS	NS	NS	---	---	---	---	---
		6-Month	On	NS	NS	NS	---	---	---	---	---
		1-Year	Off	1.5	7.8	50	---	---	---	---	---
		2-Year	On	13.0	6.5	120	---	---	---	---	---
		3-Year	On	17.5	3.9	50	---	---	---	---	---
		4-Year	On	10.5	6.0	88	---	---	---	---	---
		4-Year	Off	5.0	3.7	66	140	<0.002	0.036	0.11	0.32
VMP-2	32	Initial	Off	4.0	7.8	97	---	---	---	---	---
		3-Week	On	20.5	NS	NS	---	---	---	---	---
		6-Month	On	F	F	F	---	---	---	---	---
		1-Year	Off	14.8	0.6	48	---	---	---	---	---
		2-Year	On	20.0	0.5	10	---	---	---	---	---
		3-Year	On	20.5	0.5	22	---	---	---	---	---
		4-Year	On	20.8	0.3	2	---	---	---	---	---
		4-Year	Off	17.5	0.5	230	---	---	---	---	---
VMP-2	43	Initial	Off	3.5	6.0	90	---	---	---	---	---
		3-Week	On	18.0	NS	NS	---	---	---	---	---
		6-Month	On	F	F	F	---	---	---	---	---
		1-Year	Off	20.0	0.0	---	---	---	---	---	---
		2-Year	On	F	F	F	---	---	---	---	---
		3-Year	On	F	F	F	---	---	---	---	---
		4-Year	On	F	F	F	---	---	---	---	---
		4-Year	Off	20.5	0.2	NS	---	---	---	---	---
VMP-2	49	Initial	Off	0.0	6.8	370	---	---	---	---	---
		3-Week	On	F	F	F	---	---	---	---	---
		6-Month	On	F	F	F	---	---	---	---	---
		1-Year	Off	1.0	7.7	220	610	<0.011	<0.011	1.6	2.1
		2-Year	On	F	F	F	---	---	---	---	---
		3-Year	On	F	F	F	---	---	---	---	---
		4-Year	On	F	F	F	---	---	---	---	---

TABLE 1 (continued)
SOIL GAS FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
DAVIS GLOBAL COMMUNICATIONS SITE
DAVIS, CALIFORNIA

				Field Screening Data			Laboratory Analytical Data				
Sample Location	Sample Depth (ft bgs)	Sampling Event	Blower Status	O_2 (%)	CO_2 (%)	TVH (ppmv)	TPH-jf (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl-benzene (ppmv)	Total Xylenes (ppmv)
VMP-3	10	Initial	Off	18.0	1.4	46	---	---	---	---	---
		3-Week	On	7.5	NS	NS	---	---	---	---	---
		6-Month	On	20.8	1.2	4	---	---	---	---	---
		1-Year	Off	14.0	4.5	30	---	---	---	---	---
		2-Year	On	18.5	3.2	85	---	---	---	---	---
		3-Year	On	18.2	2.5	38	---	---	---	---	---
		4-Year	On	19.8	2.5	48	---	---	---	---	---
		4-Year	Off	9.5	3.0	30	---	---	---	---	---
VMP-3	26.5	Initial	Off	8.0	5.8	67	---	---	---	---	---
		3-Week	On	17.0	NS	NS	---	---	---	---	---
		6-Month	On	20.1	0.8	2	---	---	---	---	---
		1-Year	Off	11.3	1.0	20	---	---	---	---	---
		2-Year	On	19.2	2.2	70	---	---	---	---	---
		3-Year	On	20.0	1.8	30	---	---	---	---	---
		4-Year	On	20.1	1.7	35	---	---	---	---	---
		4-Year	Off	15.0	1.6	30	---	---	---	---	---
VMP-3	35	Initial	Off	4.4	7.7	76	---	---	---	---	---
		3-Week	On	19.0	NS	NS	---	---	---	---	---
		6-Month	On	F	F	F	---	---	---	---	---
		1-Year	Off	4.1	3.2	28	---	---	---	---	---
		2-Year	On	F	F	F	---	---	---	---	---
		3-Year	On	18.0	1.8	30	---	---	---	---	---
		4-Year	On	19.7	2.3	45	---	---	---	---	---
		4-Year	Off	13.1	2.4	70	6.2	<0.002	<0.002	0.003	0.015
VMP-3	45	Initial	Off	0.0	4.6	160	270	<0.011	<0.011	0.62	0.88
		3-Week	On	15.0	NS	NS	---	---	---	---	---
		6-Month	On	F	F	F	---	---	---	---	---
		1-Year	Off	NS	NS	NS	---	---	---	---	---
		2-Year	On	F	F	F	---	---	---	---	---
		3-Year	On	F	F	F	---	---	---	---	---
		4-Year	Off	F	F	F	---	---	---	---	---

TABLE 1 (continued)
SOIL GAS FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
DAVIS GLOBAL COMMUNICATIONS SITE
DAVIS, CALIFORNIA

				Field Screening Data			Laboratory Analytical Data				
Sample Location	Sample Depth (ft bgs)	Sampling Event	Blower Status	O_2 (%)	CO_2 (%)	TVH (ppmv)	TPH-jf (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl-benzene (ppmv)	Total Xylenes (ppmv)
P5-S	18-20	Inital	Off	21.0	0.25	0	---	---	---	---	---
		6-Month	On	20.8	0.0	0	---	---	---	---	---
		1-Year	Off	20.8	0.0	18	---	---	---	---	---
		4-Year	On	20.8	0.40	18	---	---	---	---	---
		4-Year	Off	20.7	0.0	0	---	---	---	---	---
P5-D	45-55	Initial	Off	9.5	7.5	800	---	---	---	---	---
		6-Month	On	20.8	0.80	0	---	---	---	---	---
		1-Year	Off	20.0	0.50	60	---	---	---	---	---
		4-Year	On	20.8	0.25	0	---	---	---	---	---
		4-Year	Off	20.7	0.0	0	---	---	---	---	---
CH-5	28-38	Initial	Off	0.0	8.5	350	---	---	---	---	---
		6-Month	On	20.1	0.70	8	---	---	---	---	---
		1-Year	Off	0.5	5.8	56	---	---	---	---	---
CH-11	20.4	3-Year	On	20.0	0.40	330	---	---	---	---	---
		4-Year	On	8.8	0.75	12	---	---	---	---	---
		4-Year	Off	12.2	0.50	40	3.2	<0.0024	0.0066	<0.0024	0.0083
CH-11	36	3-Year	On	20.0	0.70	12	---	---	---	---	---
		4-Year	On	20.5	0.75	22	---	---	---	---	---
		4-Year	Off	13.2	2.0	50	2.5	0.0012	0.0044	0.0011	0.0057

Notes:

1. Laboratory analysis of soil gas samples included both USEPA Methods TO-3 and TO-14. Where both analyses were performed, the maximum concentrations are shown. Only BTEX results are shown for TO-14 analyses; other TO-14 analytes are discussed in the text.
2. Soil gas sampling was performed in August 1993 (Initial), September 1993 (3-Week), March 1994 (6-Month), September 1994 (1-Year), November 1995 (2-Year), August 1996 (3-Year), June 1997 (4-Year; blower on), and July 1997 (4-Year; blower off).

TVH : total volatile hydrocarbons
TPH-jf : total petroleum hydrocarbons referenced to jet fuel (MW=156)
ft bgs : feet below ground surface
ppmv : parts per million by volume
--- : not analyzed
F : Screen was flooded (below groundwater)
NS : Not sampled (usually because soils were too tight for adequate sample purge or volume)
<0.002 : compound analyzed for, but not detected; number shown represents the sample quantitation limit
(34) : field duplicate results shown in parentheses

TABLE 2
RESPIRATION AND FUEL BIODEGRADATION RATES
DAVIS GLOBAL COMMUNICATIONS SITE
DAVIS, CALIFORNIA

Location	Depth (ft bgs)	Initial (August 1993)			6-Month (March 1994)			1-Year (September 1994)			4-Year (July 1997)		
		K_o ($\%O_2$/min)	Degradation Rate (mg/kg/yr)	Soil Temp. (°C)	K_o ($\%O_2$/min)	Degradation Rate (mg/kg/yr)	Soil Temp. (°C)	K_o ($\%O_2$/min)	Degradation Rate (mg/kg/yr)	Soil Temp. (°C)	K_o ($\%O_2$/min)	Degradation Rate (mg/kg/yr)	Soil Temp. (°C)
VW-1	10-55	NC	NC	---	0.000010	<10	---	NC	NC	---	NC	NC	---
VMP-1	15	0.0028	250	18.8	NC	NC	20.2	NC	NC	23.6	NC	NC	20.0
	25	0.0060	620	---	0.0062	720	---	0.0097	1,200	---	0.0074	1,030	---
	37.5	0.0077	160	---	NC	NC	---	0.010	500	---	0.0044	210	---
	48	0.0063	690	18.7	NC	NC	19.0	0.013	1,700	20.4	NC	NC	21.8
VMP-2	15	NC	NC	---	NC	NC	---	NC	NC	---	0.035	3,630	---
	32	0.0015	100	---	NC	NC	---	NC	NC	---	NC	NC	---
	43	0.0037	260	---	NC	NC	---	NC	NC	---	NC	NC	---
	49	0.020	1,100	---	NC	NC	---	0.050	4,200	---	NC	NC	---
VMP-3	10	NC	NC	---	0.00027	20	---	NC	NC	---	NC	NC	---
	26.5	0.0040	270	---	0.00012	10	---	NC	NC	---	NC	NC	---
	35	0.0033	350	---	NC	NC	---	0.0035	440	---	0.0019	250	---
	45	0.0067	450	---	NC	NC	---	NC	NC	---	NC	NC	---
P5-S	18-20	NC	NC	---	0	0	---	NC	NC	---	NC	NC	---
P5-D	45-55	NC	NC	---	NC	NC	---	0.0047	440	---	NC	NC	---
CH-5	28-38	NC	NC	---	0.0058	680	---	NC	NC	---	NC	NC	---

Notes:

1. Moisture contents for 6-month calculations were assumed to be the average of the initial and 1-year measurements.
2. Moisture contents for 4-year calculations were assumed to be equal to the 1-year measurements.

mg/kg/yr : milligrams of hydrocarbons per kilogram of soil per year

--- : not measured (thermocouple not installed at this location)

NC : not calculated (soils were either not oxygenated during the respiration test or location was below groundwater)

ATTACHMENT 1

Laboratory Analytical Results for CH-11 by USEPA Method TO-14

AIR TOXICS LTD.

SAMPLE NAME : CH11-20.4

ID#: 9707289B-08A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	**5073119**	**Date of Collection:**	**7/21/97**
Dil. Factor:	**4.78**	**Date of Analysis:**	**7/31/97**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)
Freon 12	2.4	Not Detected
Freon 114	2.4	Not Detected
Chloromethane	2.4	Not Detected
Vinyl Chloride	2.4	Not Detected
Bromomethane	2.4	Not Detected
Chloroethane	2.4	Not Detected
Freon 11	2.4	Not Detected
1,1-Dichloroethene	2.4	Not Detected
Freon 113	2.4	Not Detected
Methylene Chloride	2.4	Not Detected
1,1-Dichloroethane	2.4	Not Detected
cis-1,2-Dichloroethene	2.4	Not Detected
Chloroform	2.4	Not Detected
1,1,1-Trichloroethane	2.4	Not Detected
Carbon Tetrachloride	2.4	Not Detected
Benzene	2.4	Not Detected
1,2-Dichloroethane	2.4	Not Detected
Trichloroethene	2.4	Not Detected
1,2-Dichloropropane	2.4	Not Detected
cis-1,3-Dichloropropene	2.4	Not Detected
Toluene	2.4	6.6
trans-1,3-Dichloropropene	2.4	Not Detected
1,1,2-Trichloroethane	2.4	Not Detected
Tetrachloroethene	2.4	Not Detected
Ethylene Dibromide	2.4	Not Detected
Chlorobenzene	2.4	Not Detected
Ethyl Benzene	2.4	Not Detected
m,p-Xylene	2.4	5.8
o-Xylene	2.4	2.5
Styrene	2.4	Not Detected
1,1,2,2-Tetrachloroethane	2.4	Not Detected
1,3,5-Trimethylbenzene	2.4	Not Detected
1,2,4-Trimethylbenzene	2.4	Not Detected
1,3-Dichlorobenzene	2.4	Not Detected
1,4-Dichlorobenzene	2.4	Not Detected
Chlorotoluene	2.4	Not Detected
1,2-Dichlorobenzene	2.4	Not Detected
1,2,4-Trichlorobenzene	2.4	Not Detected
Hexachlorobutadiene	2.4	Not Detected
Propylene	9.6	Not Detected
1,3-Butadiene	9.6	Not Detected
Acetone	9.6	Not Detected
Carbon Disulfide	9.6	9.6
2-Propanol	9.6	Not Detected
trans-1,2-Dichloroethene	9.6	Not Detected
Vinyl Acetate	9.6	Not Detected

AIR TOXICS LTD.

SAMPLE NAME : CH11-20.4

ID#: 9707289B-08A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	**5073119**	**Date of Collection:**	**7/21/97**
Dil. Factor:	**4.78**	**Date of Analysis:**	**7/31/97**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)
Chloroprene	9.6	Not Detected
2-Butanone (Methyl Ethyl Ketone)	9.6	580
Hexane	9.6	Not Detected
Tetrahydrofuran	9.6	240
Cyclohexane	9.6	Not Detected
1,4-Dioxane	9.6	Not Detected
Bromodichloromethane	9.6	Not Detected
4-Methyl-2-pentanone	9.6	Not Detected
2-Hexanone	9.6	Not Detected
Dibromochloromethane	9.6	Not Detected
Bromoform	9.6	Not Detected
4-Ethyltoluene	9.6	Not Detected
Ethanol	9.6	Not Detected
Methyl tert-Butyl Ether	9.6	Not Detected
Heptane	9.6	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Octafluorotoluene	109	70-130
Toluene-d8	115	70-130
4-Bromofluorobenzene	112	70-130

AIR TOXICS LTD.

SAMPLE NAME : CH11-34

ID#: 9707289B-07A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	5073118	Date of Collection:	7/21/97
Dil. Factor:	1.58	Date of Analysis:	7/31/97

Compound	Rpt. Limit (ppbv)	Amount (ppbv)
Freon 12	0.79	Not Detected
Freon 114	0.79	Not Detected
Chloromethane	0.79	1.3
Vinyl Chloride	0.79	Not Detected
Bromomethane	0.79	Not Detected
Chloroethane	0.79	Not Detected
Freon 11	0.79	Not Detected
1,1-Dichloroethene	0.79	Not Detected
Freon 113	0.79	0.87
Methylene Chloride	0.79	Not Detected
1,1-Dichloroethane	0.79	Not Detected
cis-1,2-Dichloroethene	0.79	Not Detected
Chloroform	0.79	Not Detected
1,1,1-Trichloroethane	0.79	6.0
Carbon Tetrachloride	0.79	Not Detected
Benzene	0.79	1.2
1,2-Dichloroethane	0.79	Not Detected
Trichloroethene	0.79	2.2
1,2-Dichloropropane	0.79	Not Detected
cis-1,3-Dichloropropene	0.79	Not Detected
Toluene	0.79	4.4
trans-1,3-Dichloropropene	0.79	Not Detected
1,1,2-Trichloroethane	0.79	Not Detected
Tetrachloroethene	0.79	12
Ethylene Dibromide	0.79	Not Detected
Chlorobenzene	0.79	Not Detected
Ethyl Benzene	0.79	1.1
m,p-Xylene	0.79	3.8
o-Xylene	0.79	1.9
Styrene	0.79	Not Detected
1,1,2,2-Tetrachloroethane	0.79	Not Detected
1,3,5-Trimethylbenzene	0.79	Not Detected
1,2,4-Trimethylbenzene	0.79	1.3
1,3-Dichlorobenzene	0.79	Not Detected
1,4-Dichlorobenzene	0.79	Not Detected
Chlorotoluene	0.79	Not Detected
1,2-Dichlorobenzene	0.79	Not Detected
1,2,4-Trichlorobenzene	0.79	Not Detected
Hexachlorobutadiene	0.79	Not Detected
Propylene	3.2	Not Detected
1,3-Butadiene	3.2	Not Detected
Acetone	3.2	23
Carbon Disulfide	3.2	13
2-Propanol	3.2	3.6
trans-1,2-Dichloroethene	3.2	Not Detected
Vinyl Acetate	3.2	Not Detected

AIR TOXICS LTD.

SAMPLE NAME : CH11-34

ID#: 9707289B-07A

EPA METHOD TO-14 GC/MS Full Scan

File Name:	**5073118**	**Date of Collection:**	**7/21/97**
Dil. Factor:	**1.58**	**Date of Analysis:**	**7/31/97**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)
Chloroprene	3.2	Not Detected
2-Butanone (Methyl Ethyl Ketone)	3.2	250
Hexane	3.2	Not Detected
Tetrahydrofuran	3.2	100
Cyclohexane	3.2	Not Detected
1,4-Dioxane	3.2	Not Detected
Bromodichloromethane	3.2	Not Detected
4-Methyl-2-pentanone	3.2	Not Detected
2-Hexanone	3.2	Not Detected
Dibromochloromethane	3.2	Not Detected
Bromoform	3.2	Not Detected
4-Ethyltoluene	3.2	Not Detected
Ethanol	3.2	Not Detected
Methyl tert-Butyl Ether	3.2	Not Detected
Heptane	3.2	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Octafluorotoluene	103	70-130
Toluene-d8	115	70-130
4-Bromofluorobenzene	108	70-130